UNITED STATES PATENT APPLICATION

FOR

METHOD AND APPARATUS FOR IMPLEMENTING MEASUREMENT OR INSTRUMENTATION ON PRODUCTION EQUIPMENT

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METHOD AND APPARATUS FOR IMPLEMENTING MEASUREMENT OR INSTRUMENTATION ON PRODUCTION EQUIPMENT

FIELD OF THE INVENTION

The present invention relates generally to production equipment and more particularly to a method and apparatus for implementing measurement instrumentation on production equipment.

BACKGROUND OF THE INVENTION

The current practice in the semiconductor industry is to have a stand-alone metrology or inspection tool along with the process tools inside of a fab. Recent technology developments in instrumentation and metrology have driven down the size of this equipment. The trend is for process tool equipment makers to incorporate these new smaller inspection and metrology modules inside of their equipment. This provides a faster and tighter "closing the loop" on process tool performance while lowering overall costs.

There are limitations to this approach. One is that process tool OEMs are usually limited to offering only one integrated metrology solution on their equipment. The second is the high cost and lengthy development time of designing in a metrology module into their tool.

SUMMARY OF THE INVENTION

A module for use in a process tool is disclosed. The module comprising an enclosure for housing a device to be tested; and a frame coupled to the enclosure. The frame includes a standard interface to the process tool and a kinematic interface to the enclosure to facilitate repeatable and high accuracy docking of the enclosure. These could be inspection components,

measurement devices or other forms of instrumentation that are used for gathering information and/or analyzing data. The equipment could be used for, but not limited to, the fabrication of substrates, including semiconductor devices, reticles, and other products.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a standard integrated module (SIM) assembly in accordance with the present invention.

Figure 2 is an exploded view of the SIM assembly in accordance with the present invention. As is seen, the SIM comprises an enclosure and a frame.

Figure 3 illustrates a front view of the SIM enclosure in accordance with the present invention.

Figure 4 illustrates an interior perspective of the front view of the SIM enclosure illustrated in Figure 3.

Figure 5 illustrates a side view of the SIM assembly in accordance with the present invention.

Figure 6 is an interior perspective of the side view of the SIM assembly illustrated in Figure 5.

Figure 7 illustrates a bottom view of the SIM assembly in accordance with the present invention.

Figure 8 illustrates the front view of the frame of the SIM assembly in accordance with the present invention.

Figure 9 illustrates a back view of the frame.

Figure 10 illustrates the SIM assembly installed on an equipment front end module

(EFEM).

Figure 11 illustrates the internal air path across the substrate.

Figure 12 illustrates the internal air path for cooling the electronics and other equipment.

Figure 13 illustrates the kinematic interface on the frame.

Figure 14 illustrates a cone or V groove as a connector for the module.

Figure 15 illustrates a flat surface as a connector for the module.

DETAILED DESCRIPTION

The present invention relates generally to production equipment and more particularly to a method and apparatus for implementing measurement or instrumentation on production equipment. The following description is presented to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent application and its requirements. Various modifications to the preferred embodiment and the generic principles and features described herein will be readily apparent to those skilled in the art. Thus, the present invention is not intended to be limited to the embodiment shown but is to be accorded the widest scope consistent with the principles and features described herein.

A system and method in accordance with the present invention comprises a standard integrated module (SIM) for integrating equipment and instrumentation systems onto a process tool's Equipment Front End Module (EFEM) through a standard BOLTS interface such as a BOLTS interface. The SIM comprises a kinematic docking frame, quick access panels for easy integration and servicing; space for mounting equipment, and flexible support for integrating a wide range of measurement and other equipment.

The SIM provides a simple "Plug-N-Play" approach to developing and implementing measurement modules for both the OEM and end user. The common platform architecture of the SIM supports a wide range of equipment and applications. Its standard physical package, interface, and facilities provide a simple and straight-forward solution for end users, while providing the OEM the flexibility to customize the internal design to fit their products and applications.

The standard integrated module in accordance with the present invention can be attached to the standard load port interfaces found on the semiconductor industry EFEMs (Equipment Front End Modules). A method for attaching measurement or instrumentation devices to research and development, laboratory or production equipment is disclosed. The measurement or instrumentation devices could be, but are not limited to, inspection components, measurement devices or other forms of instrumentation that are used for gathering information and/or analyzing data. The equipment could be used for, but not limited to, the fabrication or processing of substrates, including semiconductor devices, reticles, and other products.

Enclosure 102

The enclosure 102 in a preferred embodiment of the present invention is a fabricated unit that houses the measurement or instrumentation device along with electronic or support modules. The enclosure 102 provides separate environments for the substrate and the equipment in the module. Cooling air for the electronics and other equipment in the module is isolated from the area around the substrate.

Frame 104

Figure 8 illustrates a front view of the frame 104 of the SIM assembly in accordance with the present invention. The frame 104 attaches to a vertical surface on the assembly. The size, shape, and hole locations on the frame 104 correspond to the mounting hole pattern of a standard interface such as a BOLTS interface typically found on a semiconductor process tool. The frame 104 allows the enclosure 102 to be easily and quickly attached and removed from the equipment.

Figure 9 illustrates a back view of the frame 104 as is seen. An opening 902 is provided for wafer transfer and for a clean air path. Ethernet connections 904 are provided for communications. Signal and interface connections 906 are provided for control. A connector 908 allows for a power connection.

SIM Installed on an EFEM

Figure 10 illustrates the SIM assembly installed on an equipment front end module (EFEM) 1002. An EFEM 1002 is usually found on process and metrology or measurement tools. The EFEM 1002 typically include a robot, FOUP or SMIF load ports (a 300 MM FOUP load port 1004 is shown in Figure 10), and a mini-environment for keeping the substrates clean. The function of the EFEM 1002 is to transfer the substrates from their SMIF or FOUP carriers into the various modules or locations in the tool. Load ports 1004 attach to the EFEM 1002 through a SEMI standards physical interface called BOLTS.

The SIM assembly features an air handling design that incorporates an isolated air flow path for a substrate and ducts in the panel to direct the heated air into the exhaust. There are

two separate air environments inside the SIM assembly. One environment is for cooling the electronics and other equipment and the other provides a clean environment for the substrate.

Figure 11 illustrates the internal air path across the substrate 1102. This isolated air path from the EFEM 1002 through the equipment maintains a clean, controlled environment for the substrate 1102. For the substrate environment, clean air enters in through an opening in a SIM panel 1104 from the EFEM 1002. The air travels across the substrate 1102 that is located on the instrument module's stage or chuck. The air then exits out of the SIM assembly through openings 1106 on the outside panel. This isolated air path keeps the substrate 1102 in a clean environment and minimizes exposure to contamination.

Figure 12 illustrates the internal air path for cooling the electronics and other equipment. Fans 1202 draw the heated air from the electronics and equipment and direct the air down the ducts 1204 in a side panel 1206.

Kinematic Interface

The frame 104 includes a kinematic interface to the enclosure that consists of three spherical contact points 1302 and their mating components 1304, 1306, 1308. The spherical contact points may include tooling balls, canoe balls, or similar devices with spherical shapes. The mating components are usually machined parts that have features, which may include grooves, cones, and flat surfaces. The purpose of the interface is to consistently provide an accurate physical relationship between the frame and the enclosure.

Figure 13 illustrates the kinematic interface on the frame 104. The kinematic interface allows the SIM enclosure to be easily removed and then re-installed with precision and

reliability. It usually consists of three balls or spherical shaped objects and either three machined groove features or a cone, groove and flat machined features. Figure 14 illustrates a cone or V groove as a connector for the module. Figure 15 illustrates a flat surface as a connector for the module.

Advantages / Benefits

The standard integrated module in accordance with the present invention can be attached to the standard load port interfaces found on the semiconductor industry EFEMs, thus providing two benefits:

1. Utilization of the SIM in accordance with the present invention will relieve the integrated module from having to develop a solution in house and allow them to concentrate on their core business.

2. Through utilization of the SIM in accordance with the present invention, end users can have a physical "plug and play" approach to testing and adopting different technologies in their fabrication for different processes.

Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the embodiments and those variations would be within the spirit and scope of the present invention. Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.